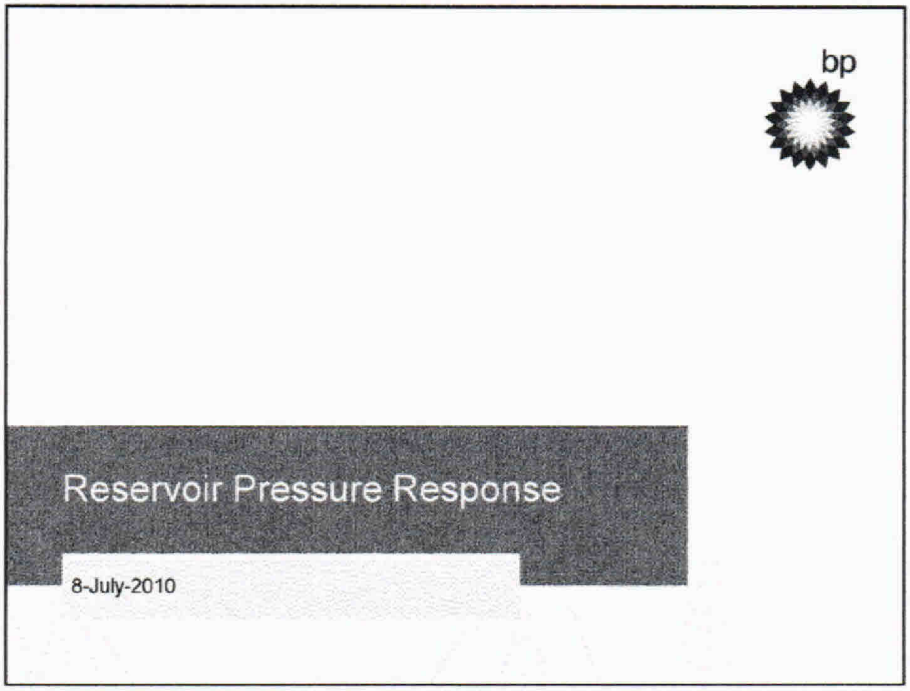


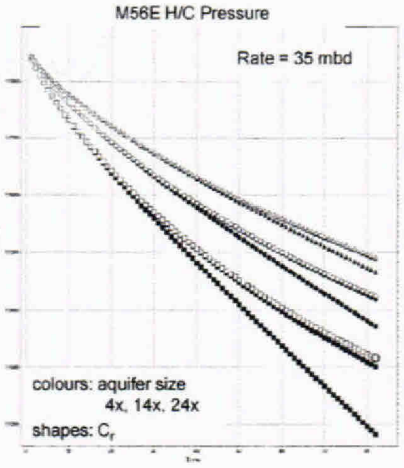
Outline

bp

- Modelling used preliminary slab model
  - Structural model incomplete Wed. evening
  - PIE used to cross-check
- Fixed Parameters:
  - M110 Size (45 mmrb)
- Sensitivity Parameters:
  - Aquifer: **3.8x**, 13.7x, 24x (larger aquifers with some K red'n)
  - Cr: 6, **12**, 18 µsips
  - Oil Rate: 35, 50, 60 mbd
  - Skin: 0, 10, 20
  - Xflow 0, ??, ?? rb/d (approximate, controlled with skin)

Depletion

- Aquifer Impact (referenced to 4x Aquifer, 6 μsips, @35 mbd)
  - No Aquifer: –800 psi
  - 13.7x Aquifer +120 psi
  - 24x Aquifer +130 psi
- Compressibility
  - 12 μsips +200 psi
  - 18 μsips +300 psi
- S.I. BHP Range (M56E, @5 hrs)
  - Near well: 7,900 - **11,030** – 11,120
  - Reservoir: 9,360 - **11,360** – 11,590
  - Recommend: new "most likely": 3.8x aquifer, 12 μsips, 35 mbd



note: values reflect additional 15 days of depletion

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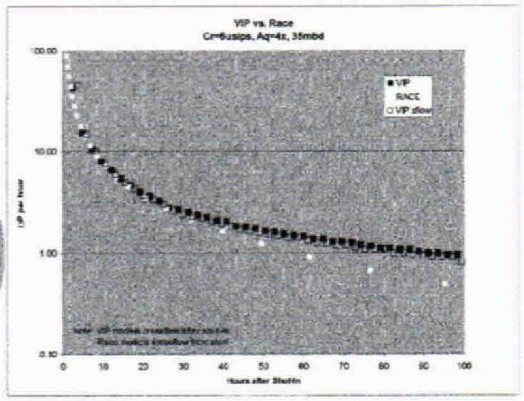
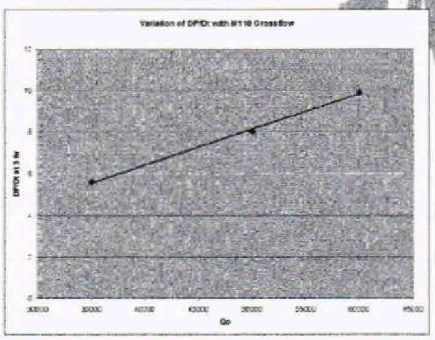
- Bottomhole pressure changes very rapidly for first 3 hours
  - $\Delta P/\Delta t$ > 30,000 psi/hr
- Differences
  - Layer crossflow
    - 2 layers v. many
  - Solution method & timesteps
- Similar solutions during critical period (5 < t < 100 hrs)

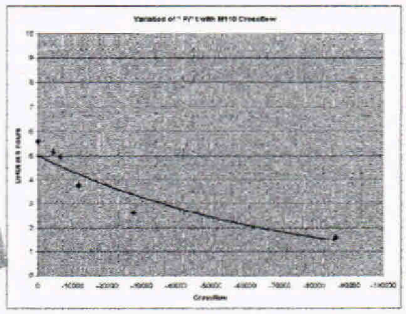


Variation of DP/Dt with Parameters: Q_o & Xflo

bp

ΔP/Δt of ~5 - 10 psi/hour for rates between 35 & 60 mbd at 5 hours of shut-in





ΔP/Δt of ~1-3 psi/hour for crossflow between 0 & 30 mbd at 5 hours of shut-in

ΔP/Δt at 5 hours

- Insensitive to:
  - Aquifer (1 psi/hr)
  - Compressibility (1 psi/hr)
- Largest sensitivities:
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  - Average production rate
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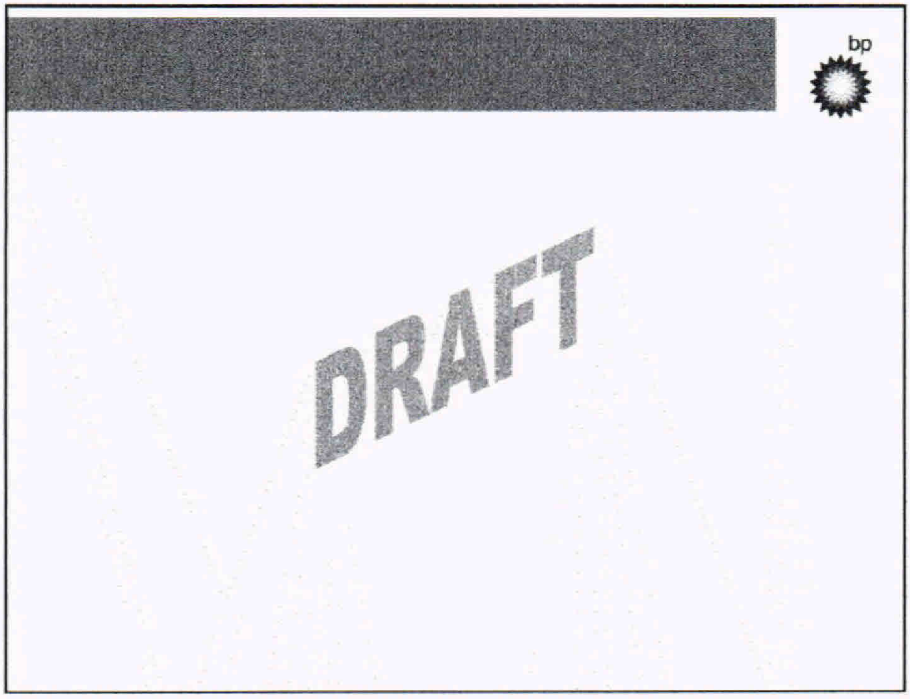

Input Data

- Data provided by GoMx Reservoir Team
- Rock Properties
  - Developed from MC252 logs
  - Permeability
    - 275 mD in main M56E sand
    - 397 mD in M56A gas/oil sand (only 2.5')
    - 86 – 110 mD in other oil sands
  - Compressibility:
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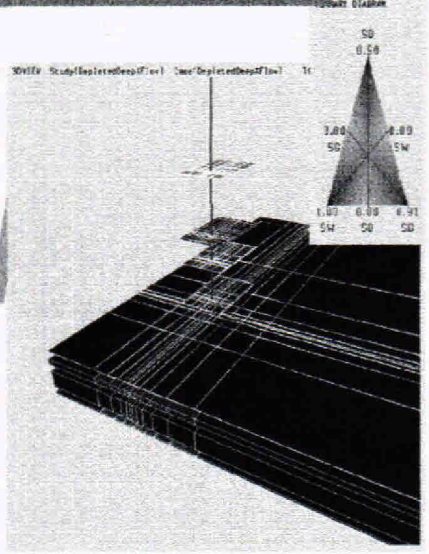
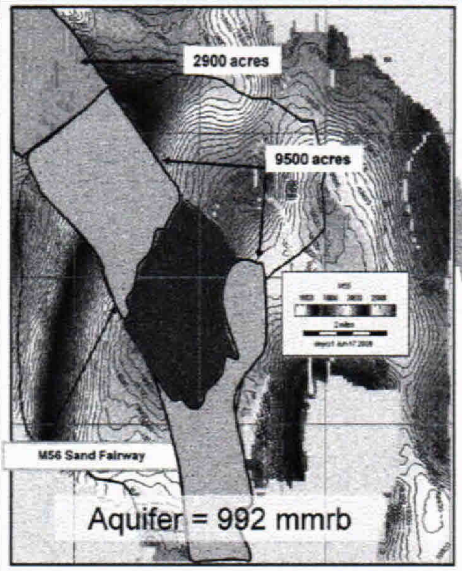
  - Fluid properties generated by EoS; volatile, near critical fluid
- tubing performance matched to GAP / Prosper work of T. Liao, A. Chitale & M Gokdemir



Macondo RF – Aquifer Size

bp



Oil Accumulation
110 mmstb = 258 mmrb

9500 acre Aquifer		
Net Sand Thickness, ft.	Porosity, %	Aquifer Size
44	13	1.5x
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66	17	2.9x

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Largest Aquifer Size – used as base case (will minimise depletion)

Depletion Response @wellbore

- PIE gives similar results to VIP
  - Constant compressibility (too low)
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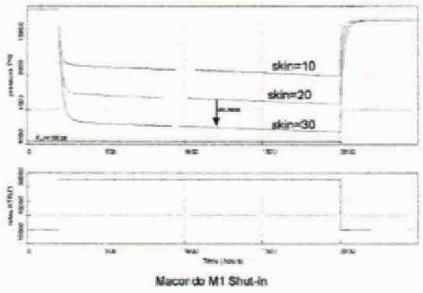
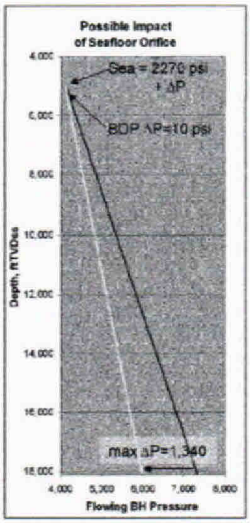
- P_{wf} drops ~8 psi/day (for 35mbd case)
- Lack of observed depletion could be due to *fixed* seafloor pressure and *large* orifice



Macondo M1 Shut-in



Conclusions

- Actual reservoir depletion dependent on:
  - Flowrate
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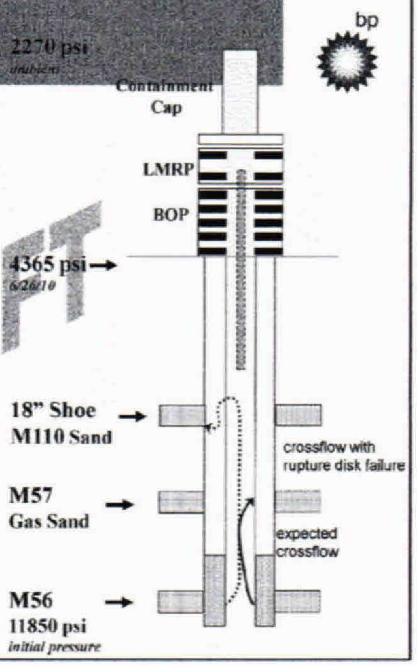
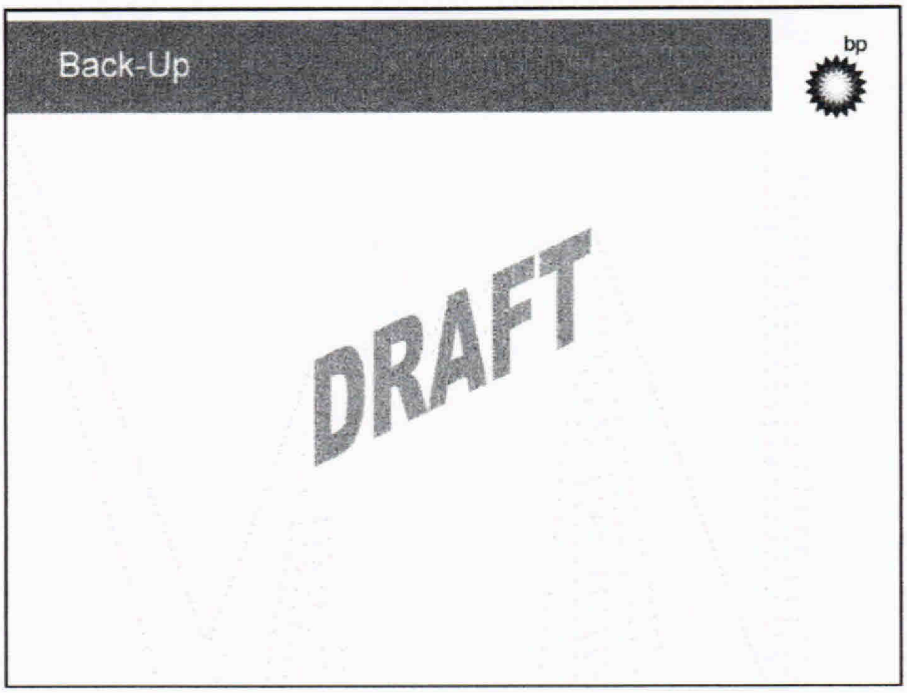
- Limited depletion observed in wellhead could be controlled by non-reservoir mechanisms
  - Large orifice
  - Flowpath / choke between BOP & reservoir
  - Broken gauge
  - Crossflow
- Largest uncertainties: flowrate and pressure drop





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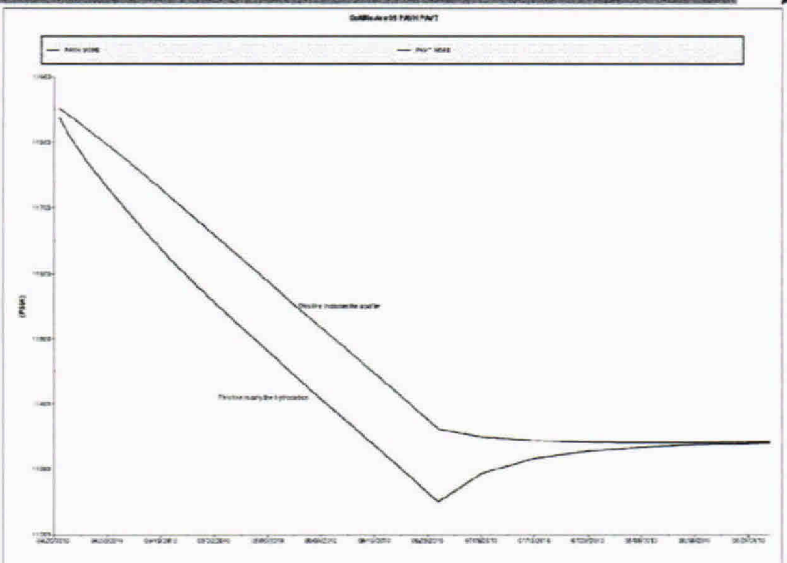

Match to "Tubing Performance"

bp

- Flowpath is a major (priniciple?) source of THP uncertainty
- Various cases considered:
  - Annular flow
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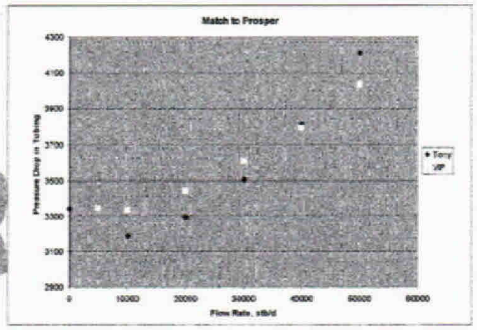

Influences on Observable Shut-In Pressure

bp

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High Wellhead Pressure

- Limited crossflow
- Well integrity above 18" shoe
  - small leak into small zone
- Large aquifer
- Lower production (higher skin)

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- Integrity failure (crossflow into M110)
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Rising THP

- Fluid Segregation
  - Only if P_{thp} < 6,650psia
  - Increase would begin at low rates or at flow cessation
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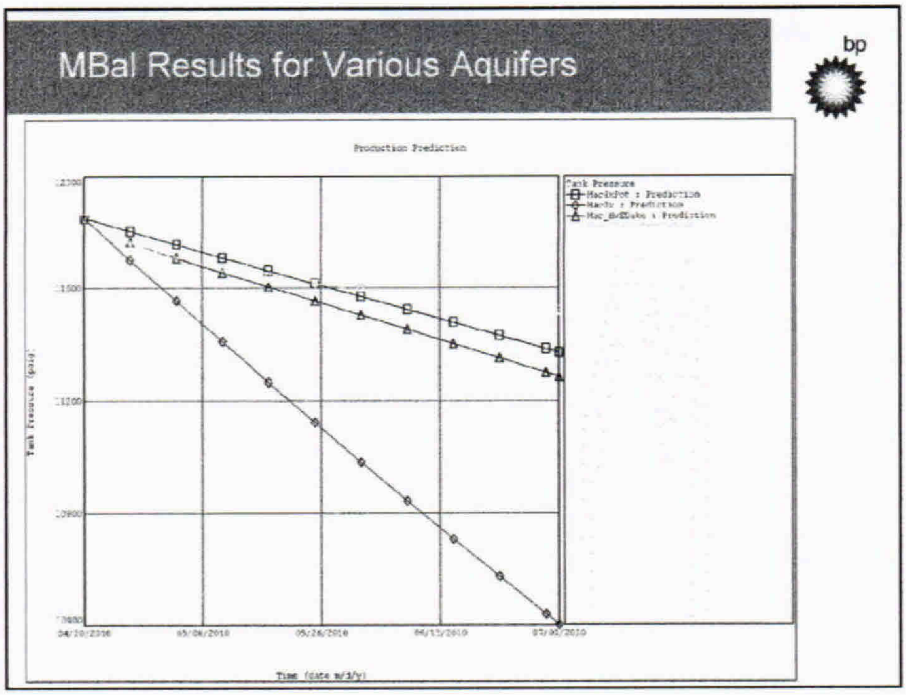
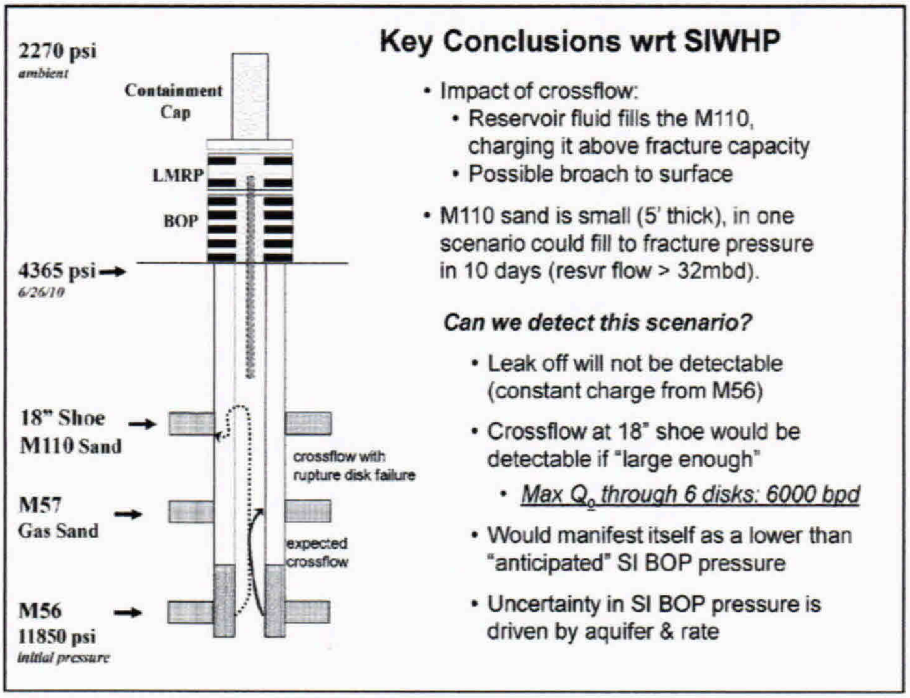
MBal Results for Various Aquifers



Future Work: Add Structure



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- Model constructed to address impact of crossflow of M57B & M56A gas sands during "top kill"
  - Response of observed pressures
  - GOR variation with time
- Requested to investigate whether depletion was consistent with known pressures below BOP
- Requested to avoid making any conclusions regarding likely rates
  - Role of flowrate investigation team

- Approach
  - Simple: tight timing, multiple unknowns
  - Single layer per reservoir (M57B to M56F, with intervening shales)
  - 10 x 12 x 17; no structure

Reservoir Pressure Response

8-July-2010

Outline

- Modelling used preliminary slab model
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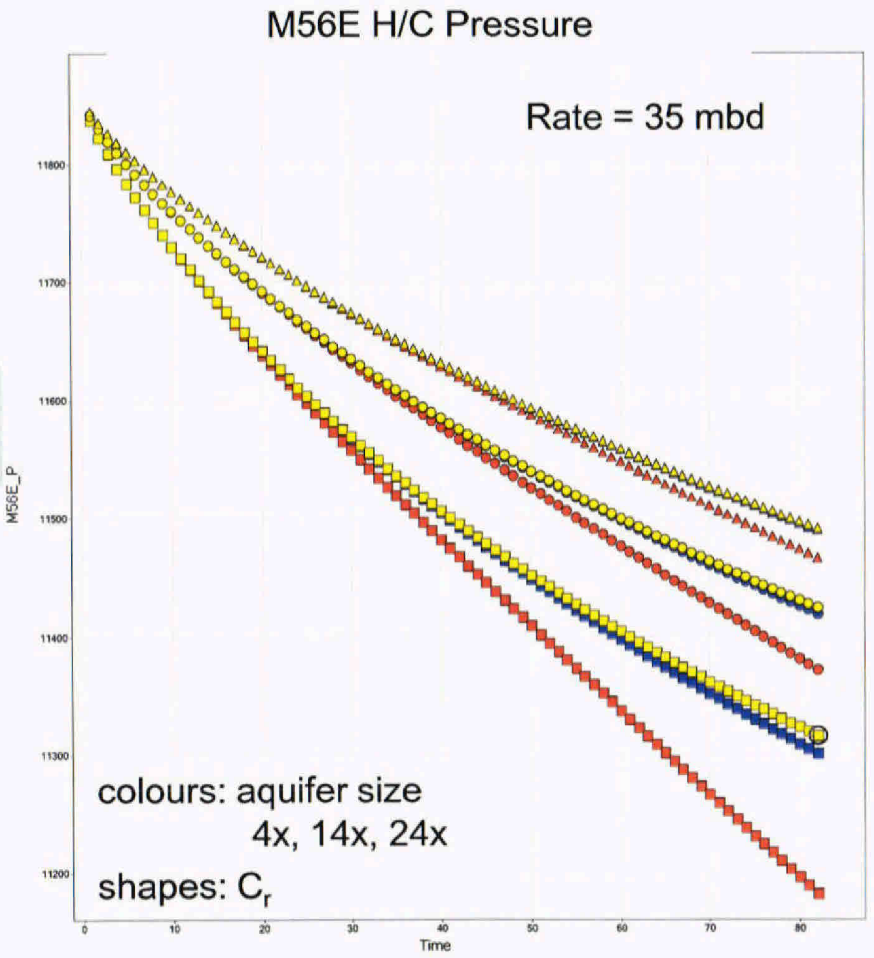
  - Recommend: new "most likely": 3.8x aquifer, 12 μsips, 35 mbd



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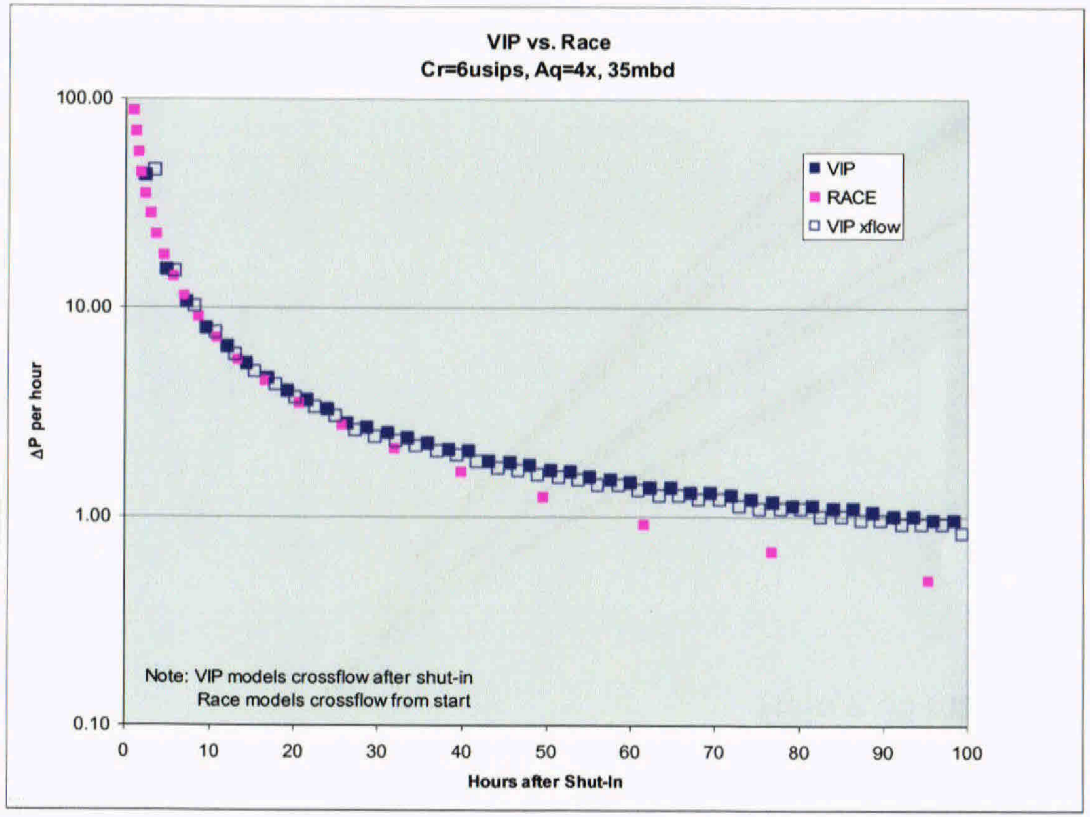

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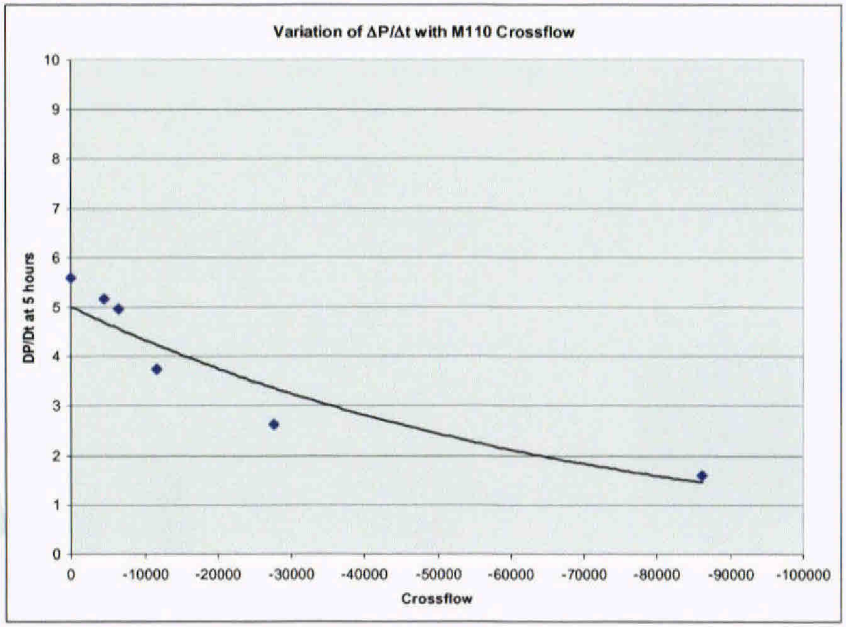

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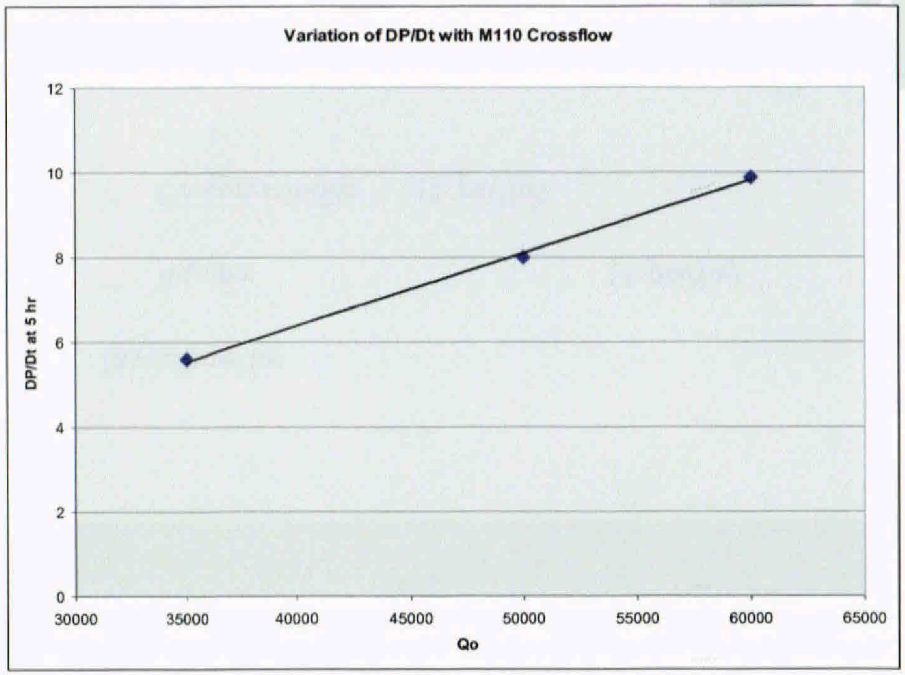

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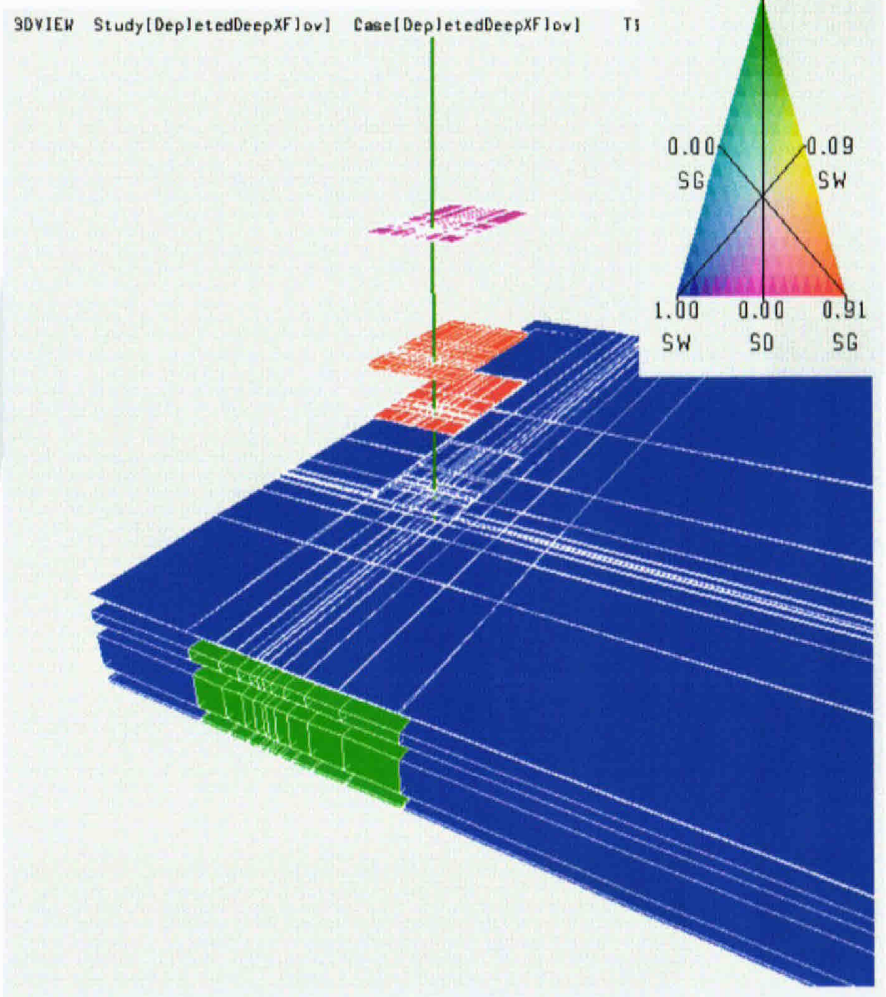

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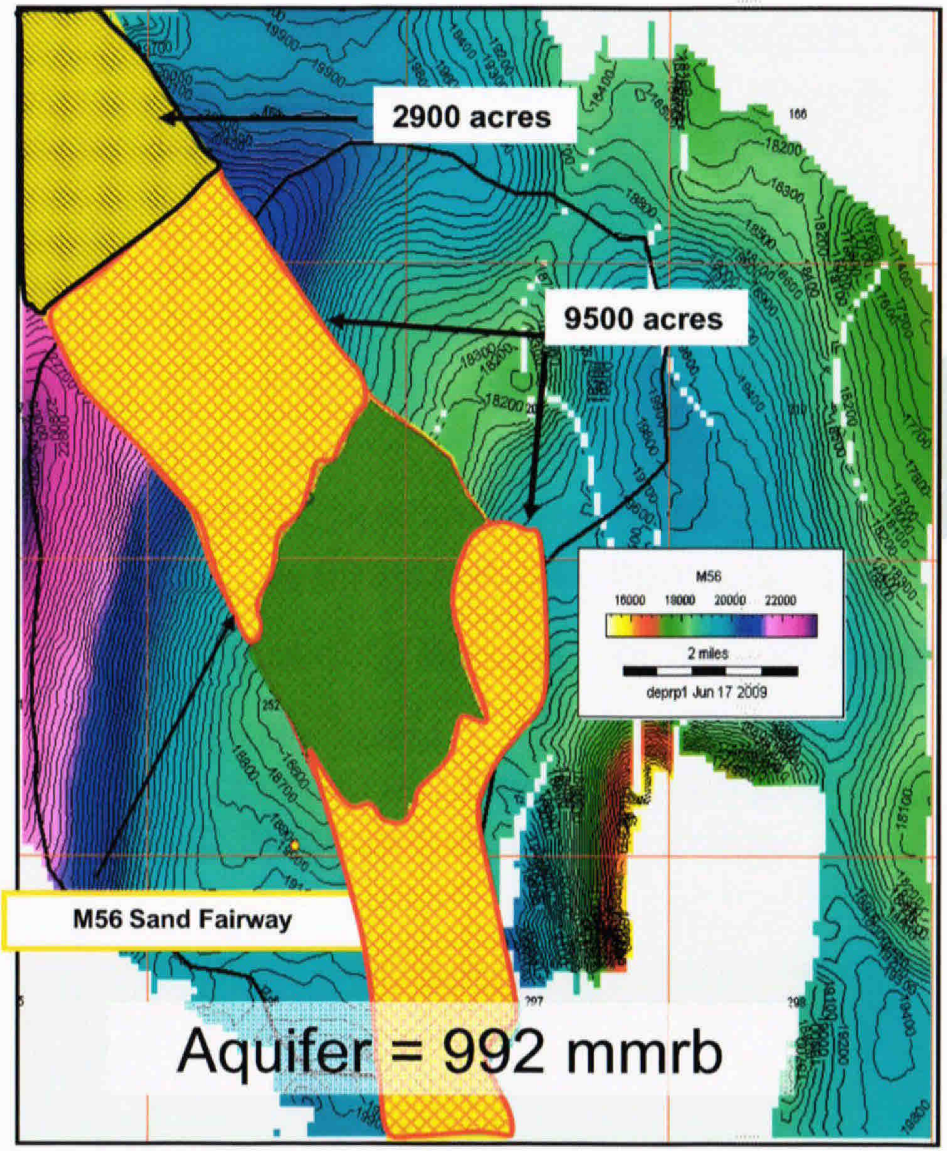

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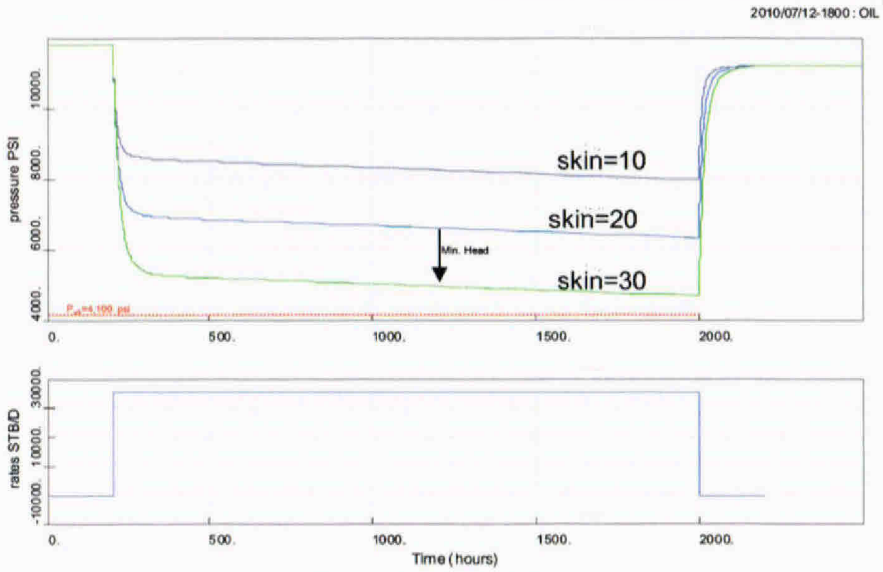
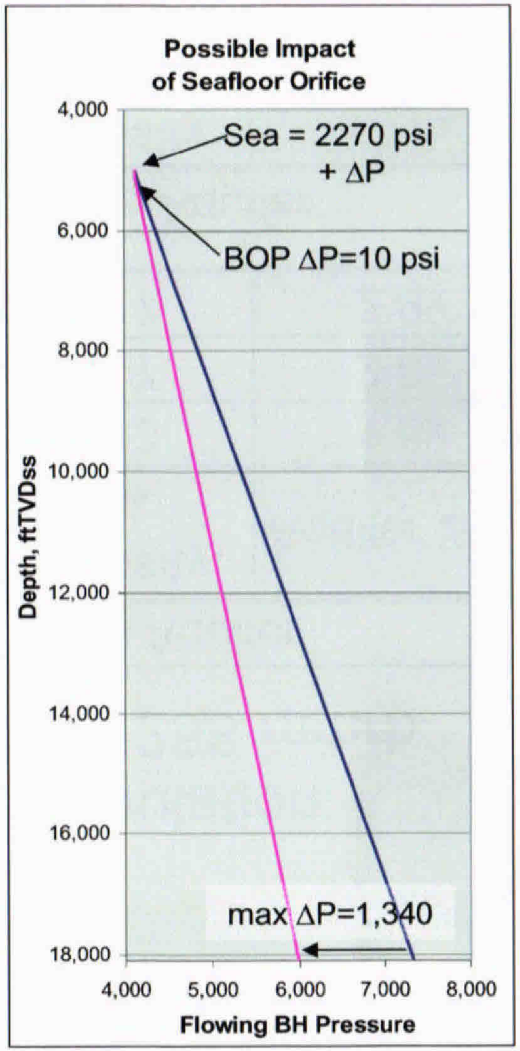


Macondo M1 Shut-In



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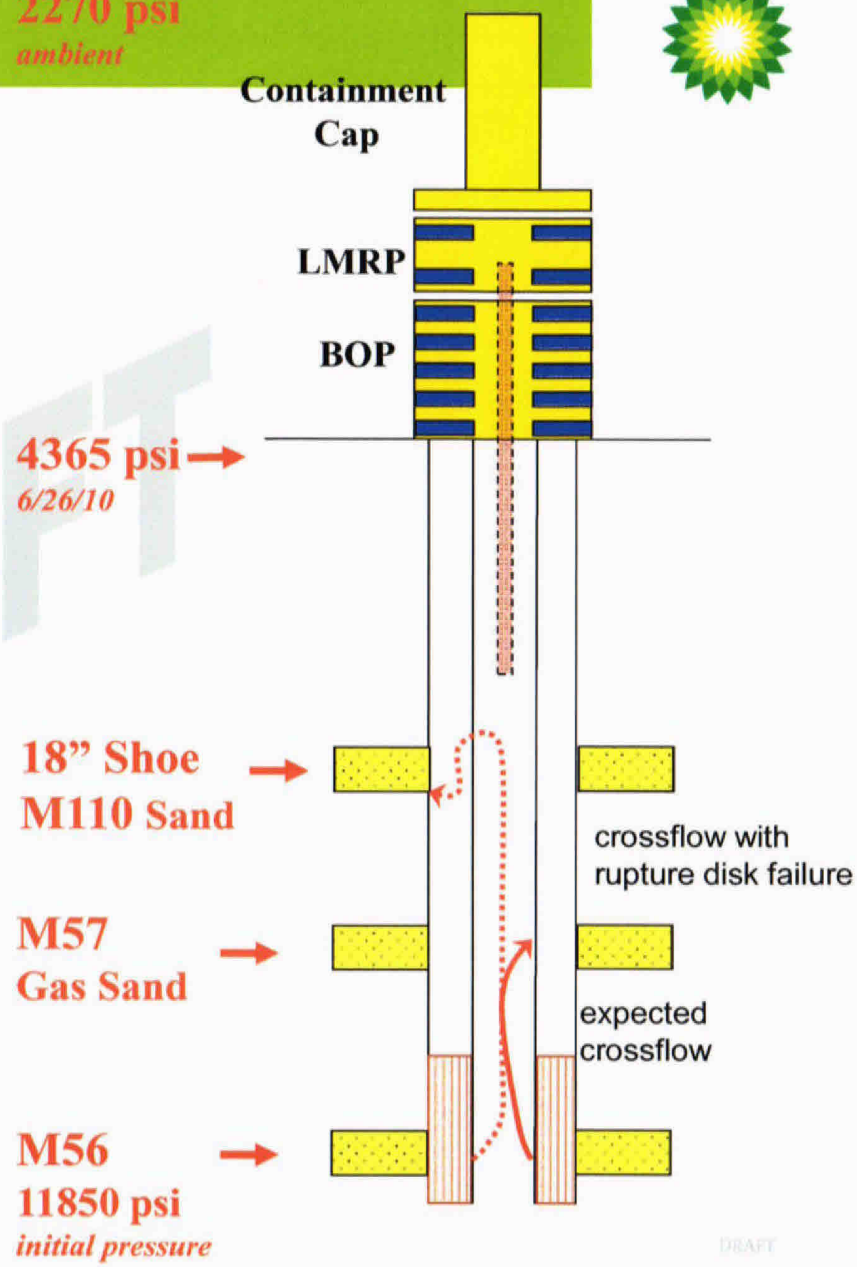
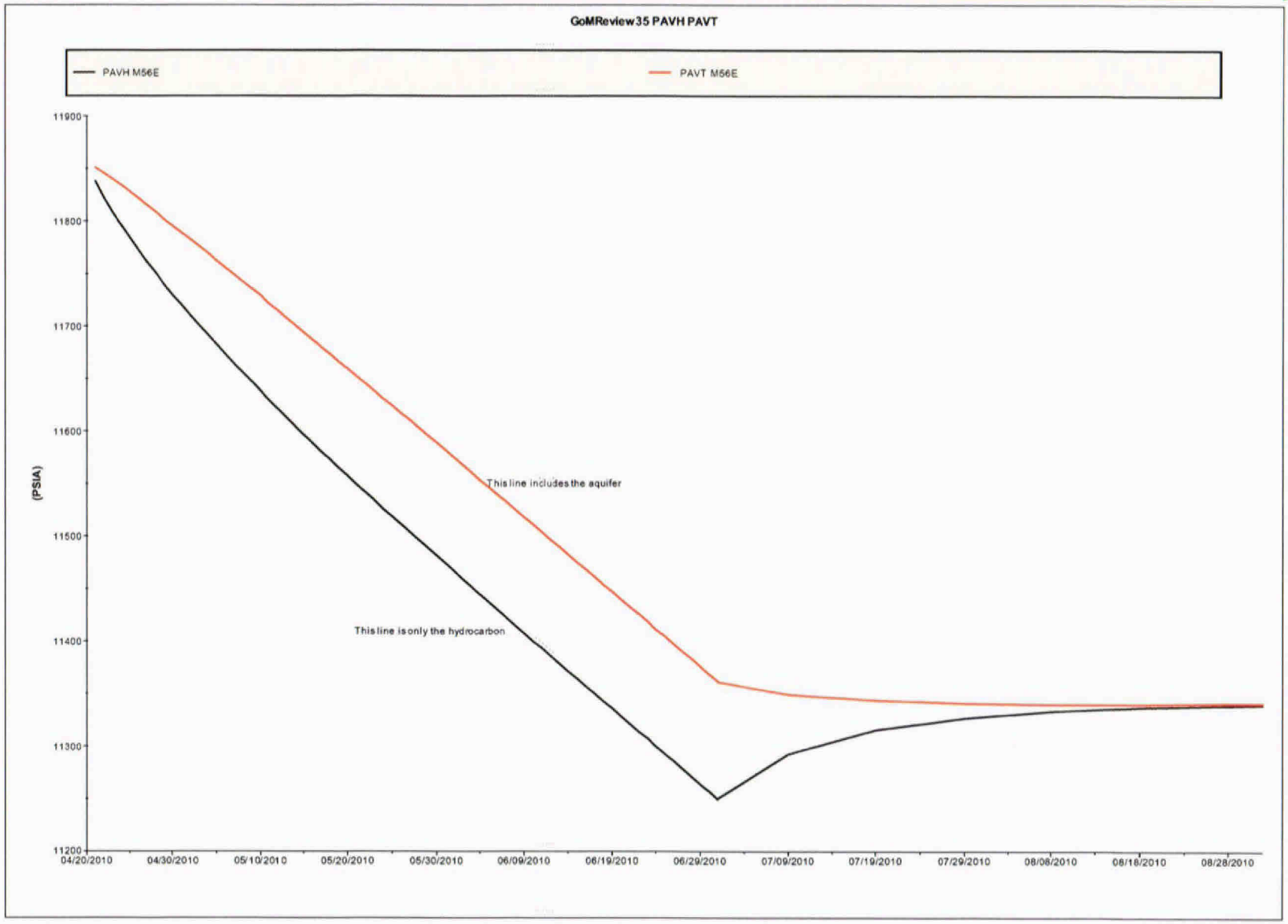


Back-Up

Difference between Aquifer & H/C Pressure



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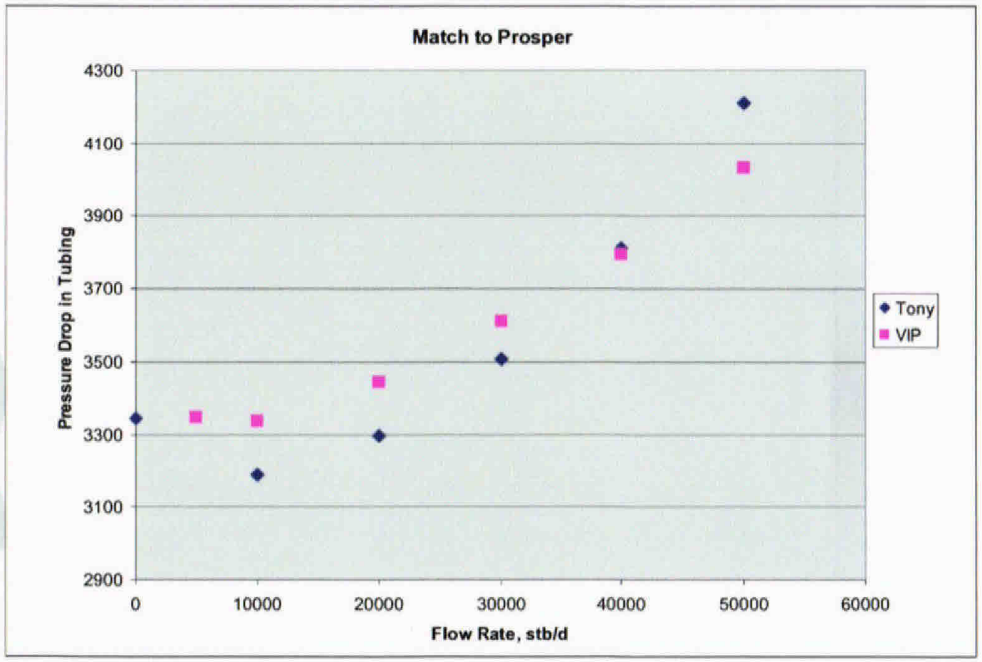

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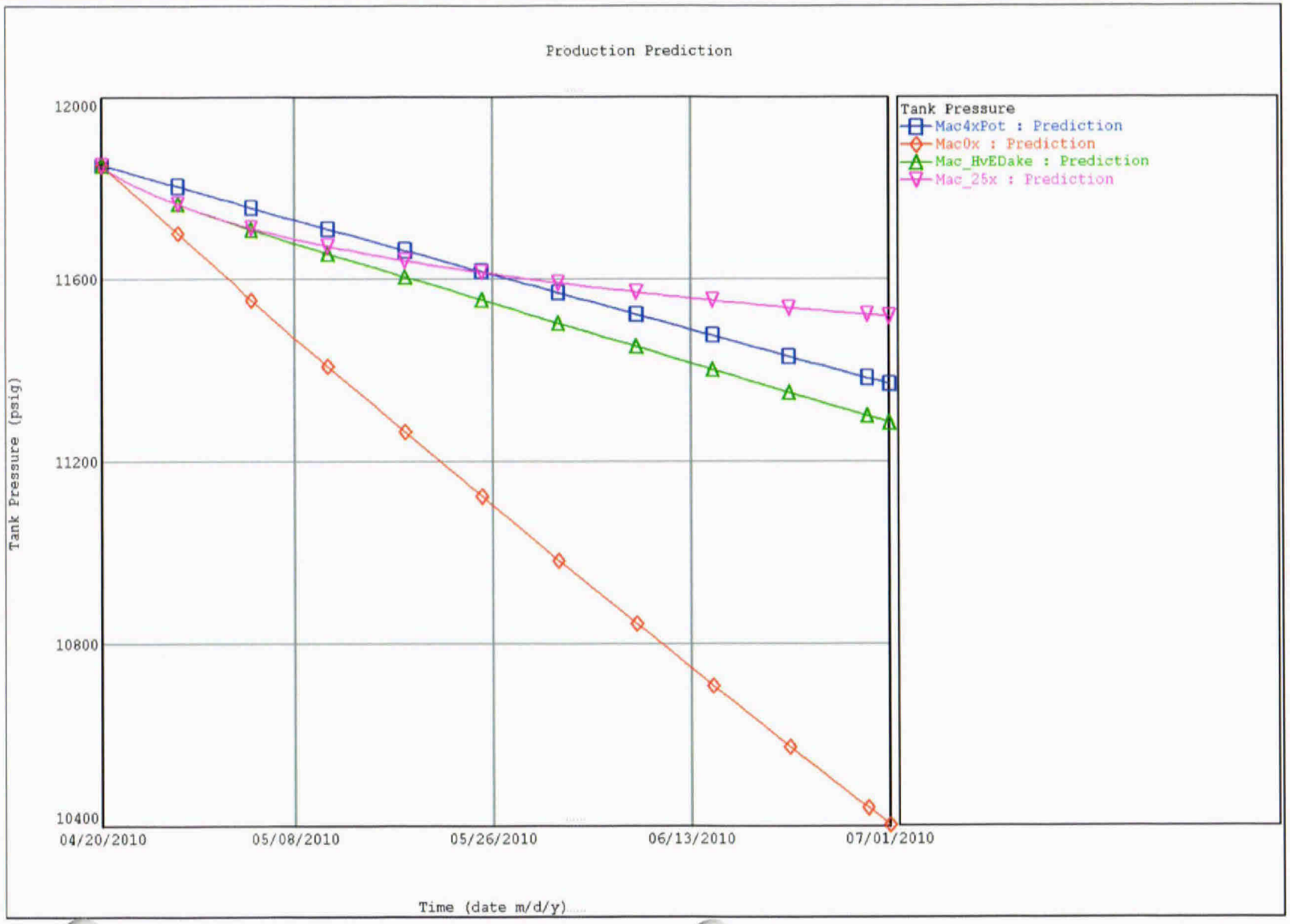

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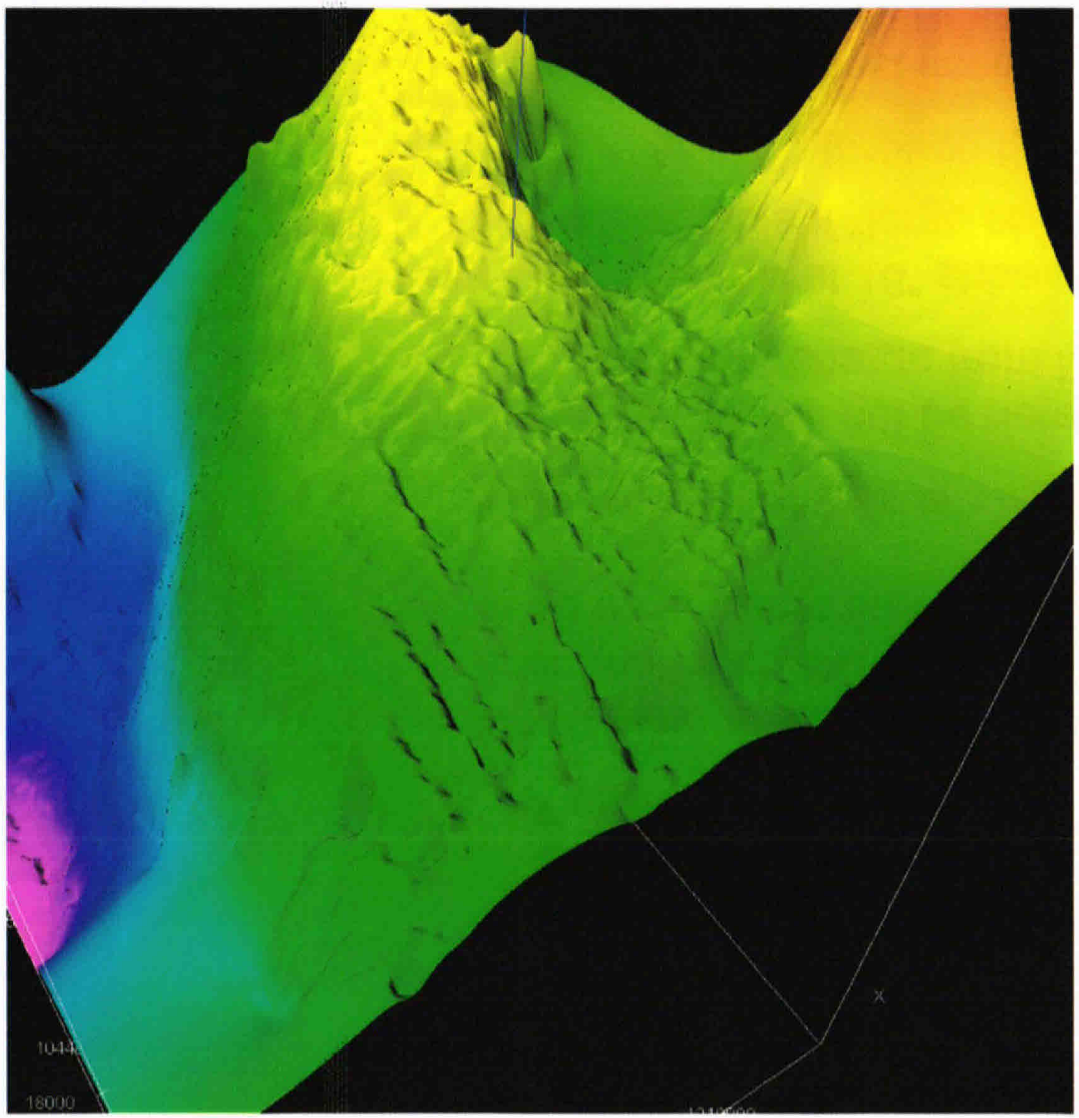

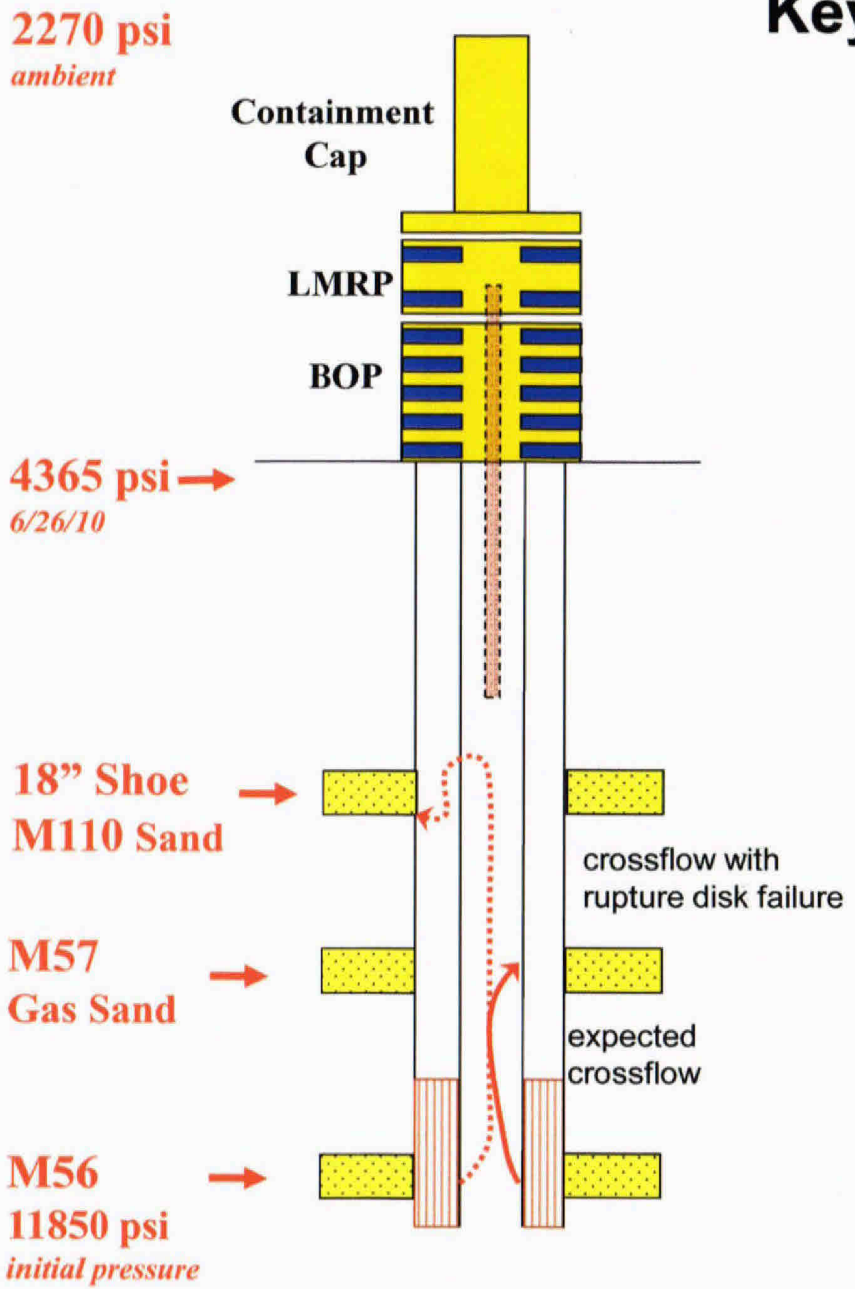

Key Conclusions wrt SIWHP

- Impact of crossflow:
  - Reservoir fluid fills the M110, charging it above fracture capacity
  - Possible broach to surface
- M110 sand is small (5' thick), in one scenario could fill to fracture pressure in 10 days (resvr flow > 32mbd).

Can we detect this scenario?

- Leak off will not be detectable (constant charge from M56)
- Crossflow at 18" shoe would be detectable if "large enough"
  - *Max Q_o through 6 disks: 6000 bpd*
- Would manifest itself as a lower than "anticipated" SI BOP pressure
- Uncertainty in SI BOP pressure is driven by aquifer & rate

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  - Response of observed pressures
  - GOR variation with time
- Requested to investigate whether depletion was consistent with known pressures below BOP
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